

# **Wind Turbine** **Setbacks:**

## **Impacts and Considerations**

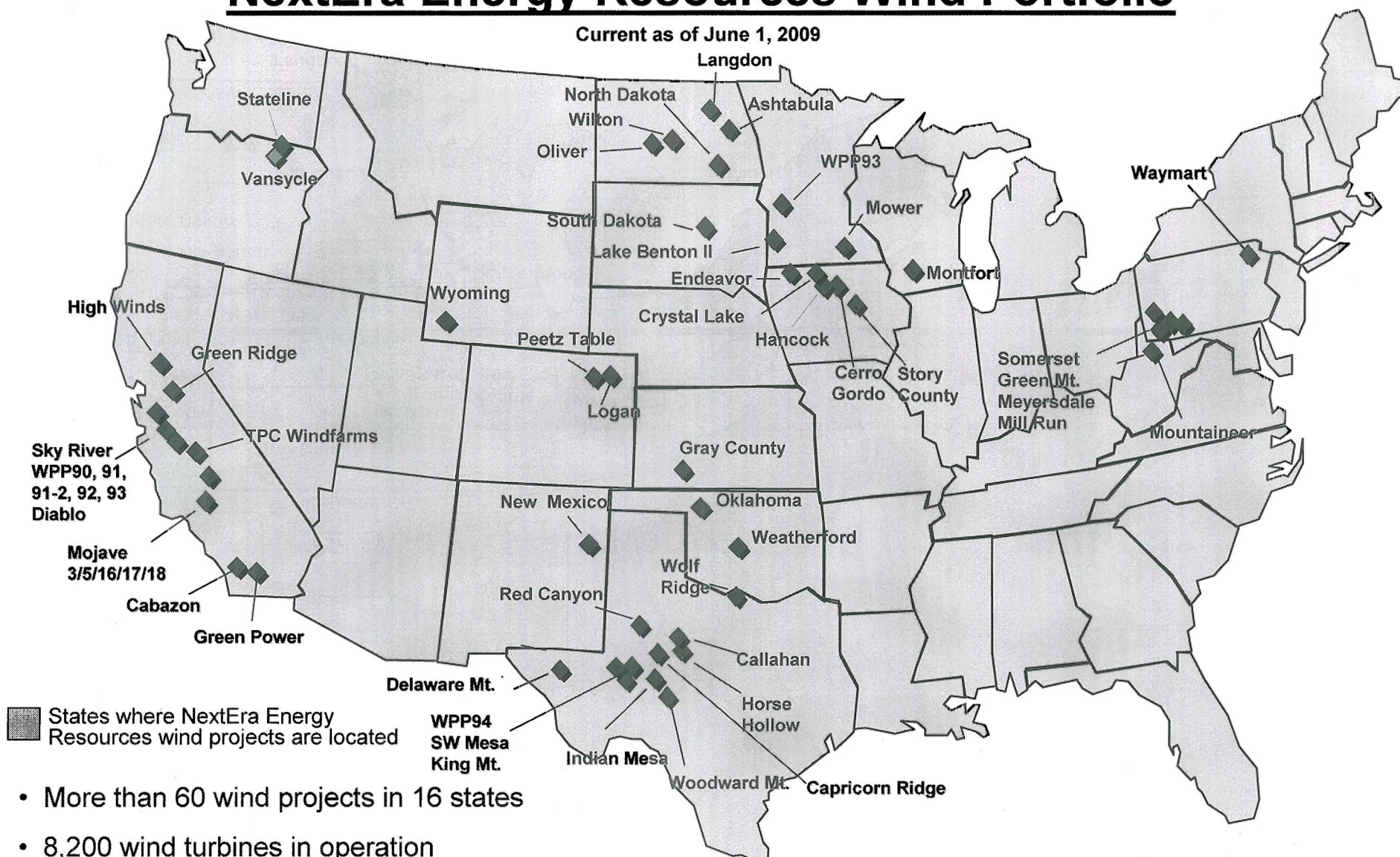
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# NextEra Energy Resources Wind Portfolio

Current as of June 1, 2009



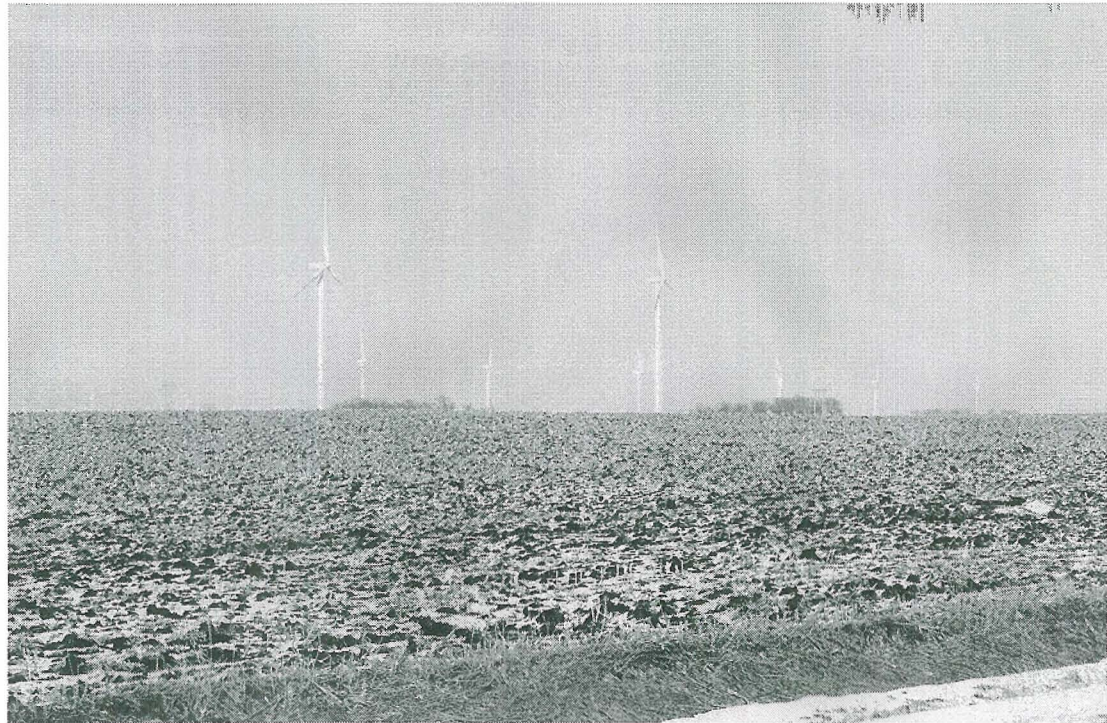
- More than 60 wind projects in 16 states
- 8,200 wind turbines in operation
- 6,300 megawatts of wind generation
- Enough electricity to power almost 2 million homes





## **Agricultural Use Dominates with Added Benefits of Wind**

- Windfarm uses only about of 1% of land within the vicinity of turbines.
- Provides additional and consistent income to the landowners, State, and County
- Provides clean, renewable energy sufficient for thousands of homes.



## Effectiveness of Setbacks

Site	# of Turbines	# of Homes within 1 mi.	Unresolved Complaints
Edgeley/Kulm	40	20	0
Langdon	133	65	0
Oliver	32	16	0
Wilton	67	32	0
Ashtabula I	131	44	1 pending
Ashtabula II	80	25	1 pending
<u>North Dakota TOTAL</u>	<u>483</u>	<u>201</u>	<u>2</u>
 <u>U.S. 65 windfarms</u>	 <u>8,200</u>	 <u>3,400 est.</u>	 <u>0</u>



## **Resolving Homeowner Complaints**

- 1. Meet the homeowner to understand the complaint.**
- 2. Measure the sound levels when and where the complaint occurs according to IEC 61400 standards to determine cause of complaint.**
- 3. Agree on mitigation as appropriate:**
  - A. Increase masking;
    - Plant trees or shrubs
    - Install a ceiling fan
  - B. Increase insulation
    - Provide heavy window treatments or window replacement
    - Provide additional insulation to walls
  - C. Adjust turbine operation
    - Repair if exceeding warranty sound levels
    - Add operational restrictions

## **Wind Turbines and Health**

- **NextEra has never received a confirmed or documented claim of health effects from its 8,200 wind turbines**
- **Sound from wind turbines of different models and sizes on different sites is different and studies of one site and one model cannot be fairly applied to others.**
- **NextEra uses turbines with “quietness warranties” assuring sound levels will not exceed pre-determined levels.**
- **NextEra has carefully measured low frequency and infrasound levels from its turbines and determined that they are below levels cited by anti-wind opponents as causing concerns.**



## **Wind Facilities Are Safe**

- **Sound levels from operating wind farms are actually less than those associated with an office environment or within the typical home.**
- **There is no peer-reviewed scientific journals or acceptance among the scientific regulatory community supporting negative health claims about wind turbines.**
- **Low frequency and infrasound levels from turbines used by NextEra Energy do not exist at the levels necessary to support the claim of “wind turbine syndrome”.**
- **“Wind turbine syndrome” is not recognized by the EPA, WHO, CDC, or any state or federal health agency in the U.S.**

## **Tom Factor**

- **Has conducted research for the U.S. Department of Energy, National Renewable Energy Laboratories, and Iowa Department of Natural Resources**
- **For NextEra Energy has sited:**
  - 25 wind farms
  - 3,000 wind turbines in 8 states including North Dakota





## **NextEra Setbacks and Turbine Siting Considerations**

- **1400-feet from homes (average is 1800+ feet)**
- **1.1 x height from roads, power lines, rails, etc.**
- **1.1 x height from adjoining properties (1.33 rotor diameters)**
- **Avoid wetlands, drainages, cultural sites, wildlife sites, communication towers, beam paths, aviation impacts, pipelines, etc.**
- **Site turbines for land use compatibility**
- **Optimize turbine performance based on terrain and prevailing wind directions**

# Array Planning

Optimize prevailing wind and use of elevated terrain

Minimize wind shadows

Minimize roads and cables

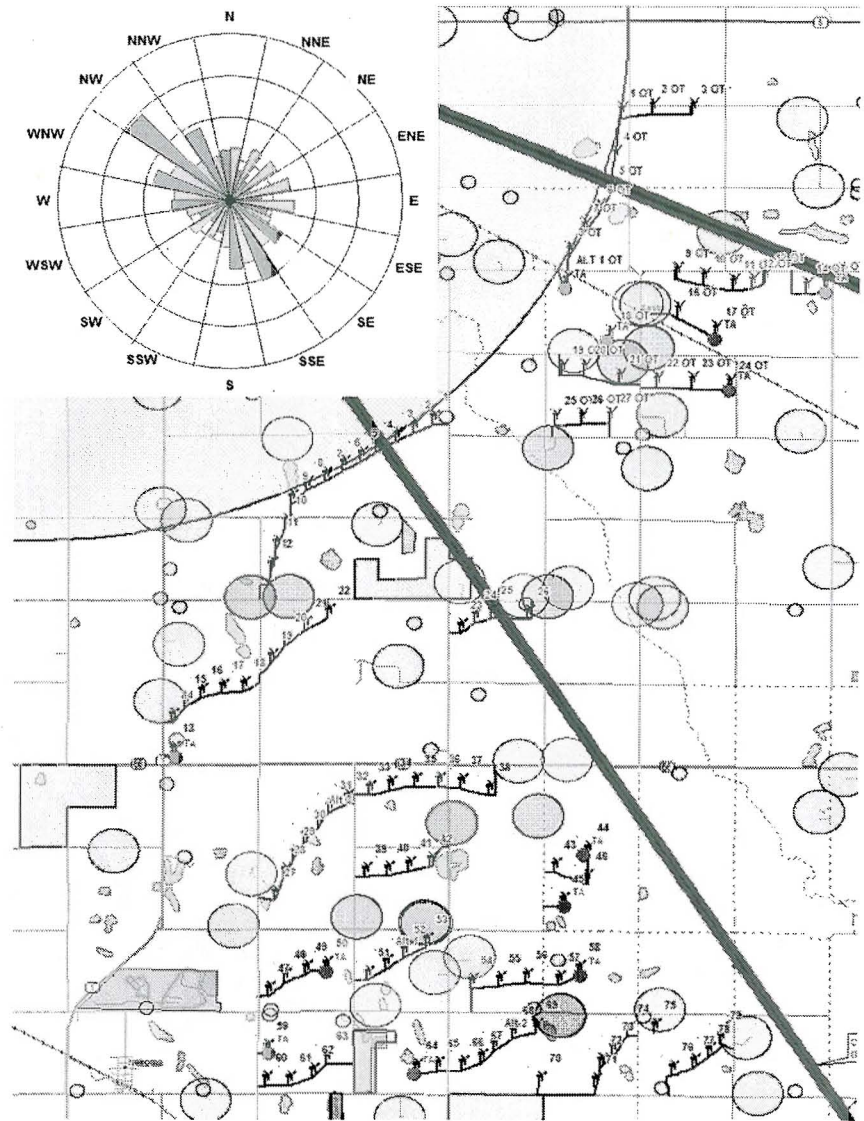
1400' setback from homes and Waterfowl Production Areas

1.1 x height setback from roads, rails, transmission lines and property lines

Avoid wetlands, archaeological sites, airport airspace, and beam paths

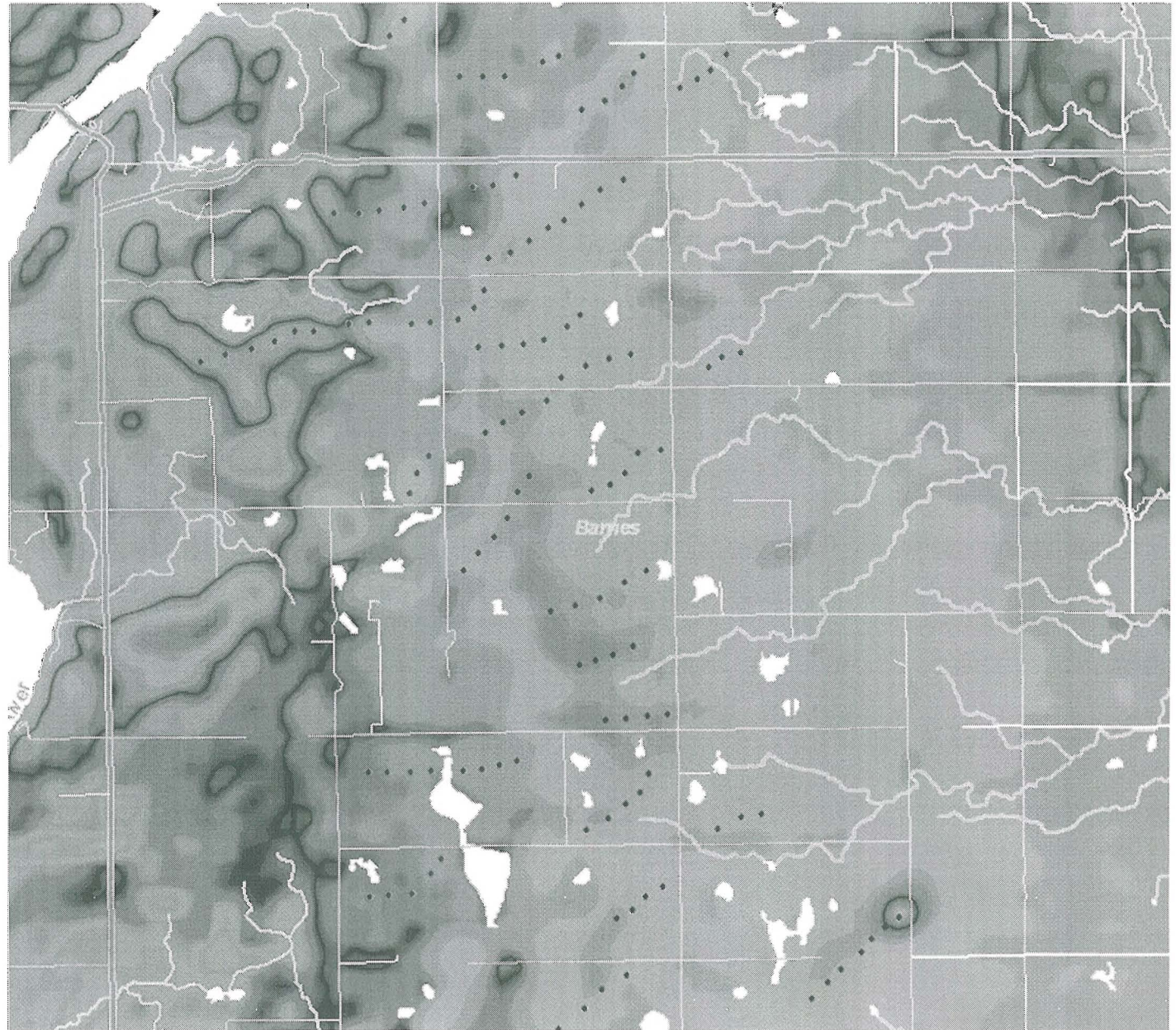
Share revenue between landowners

Consideration to farming and ranching use



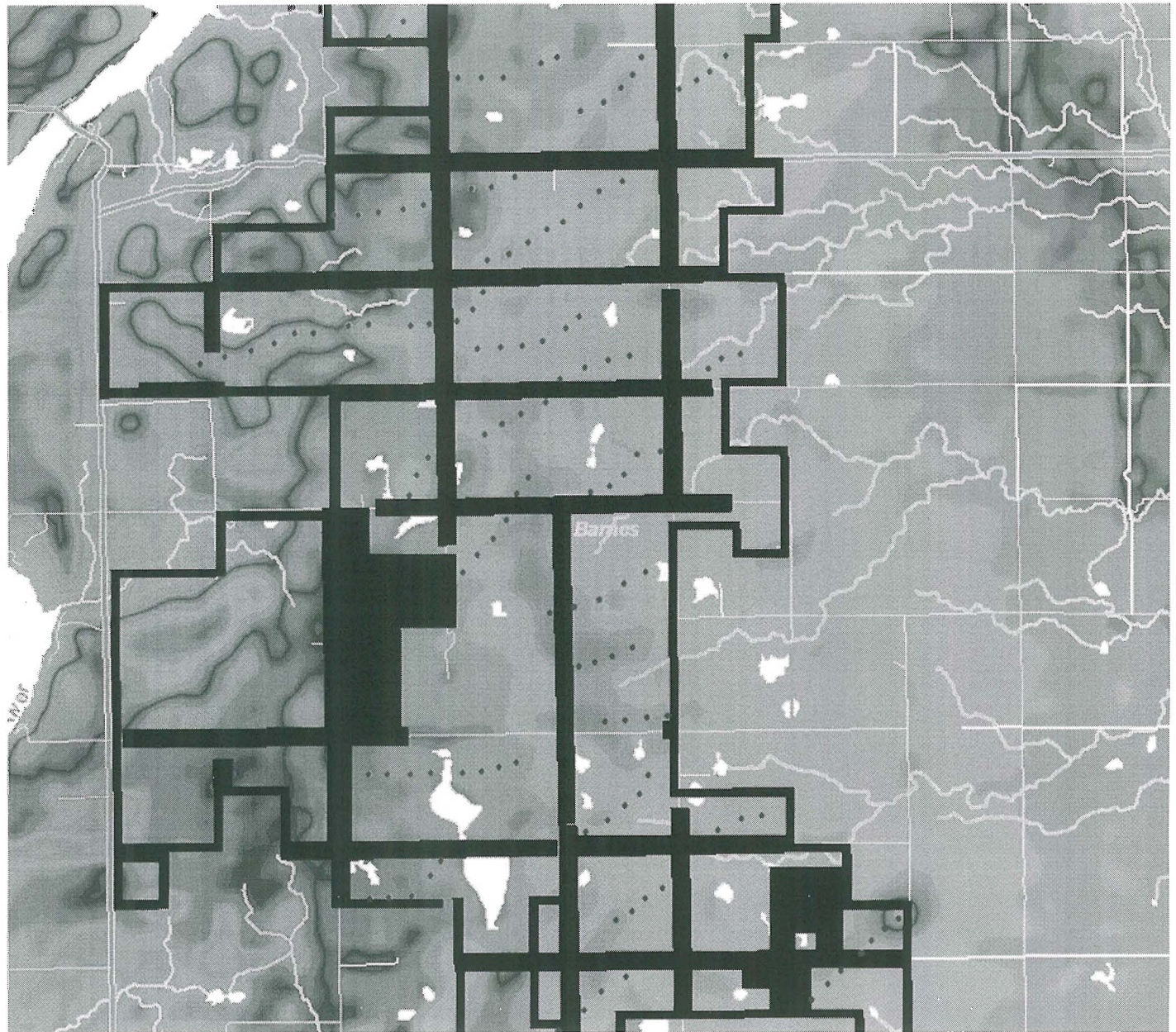


# Windmap with Turbine Layout





**Project  
Site  
boundary  
of 1.1 x  
turbine  
height  
adjoining  
properties  
and roads**



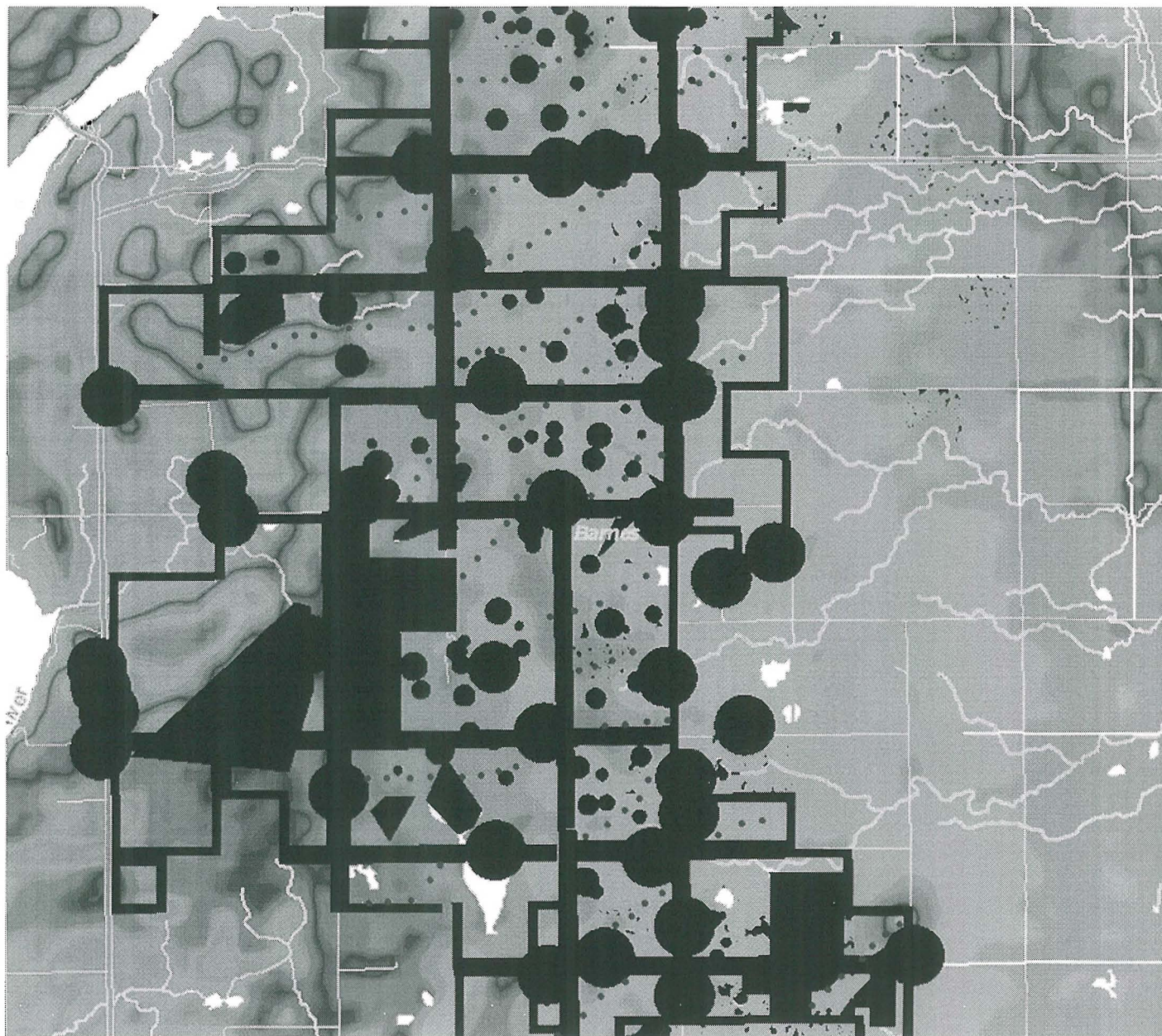


**1400 foot  
home  
setbacks**





**Wetland  
and  
unfavorable  
terrain  
setbacks**





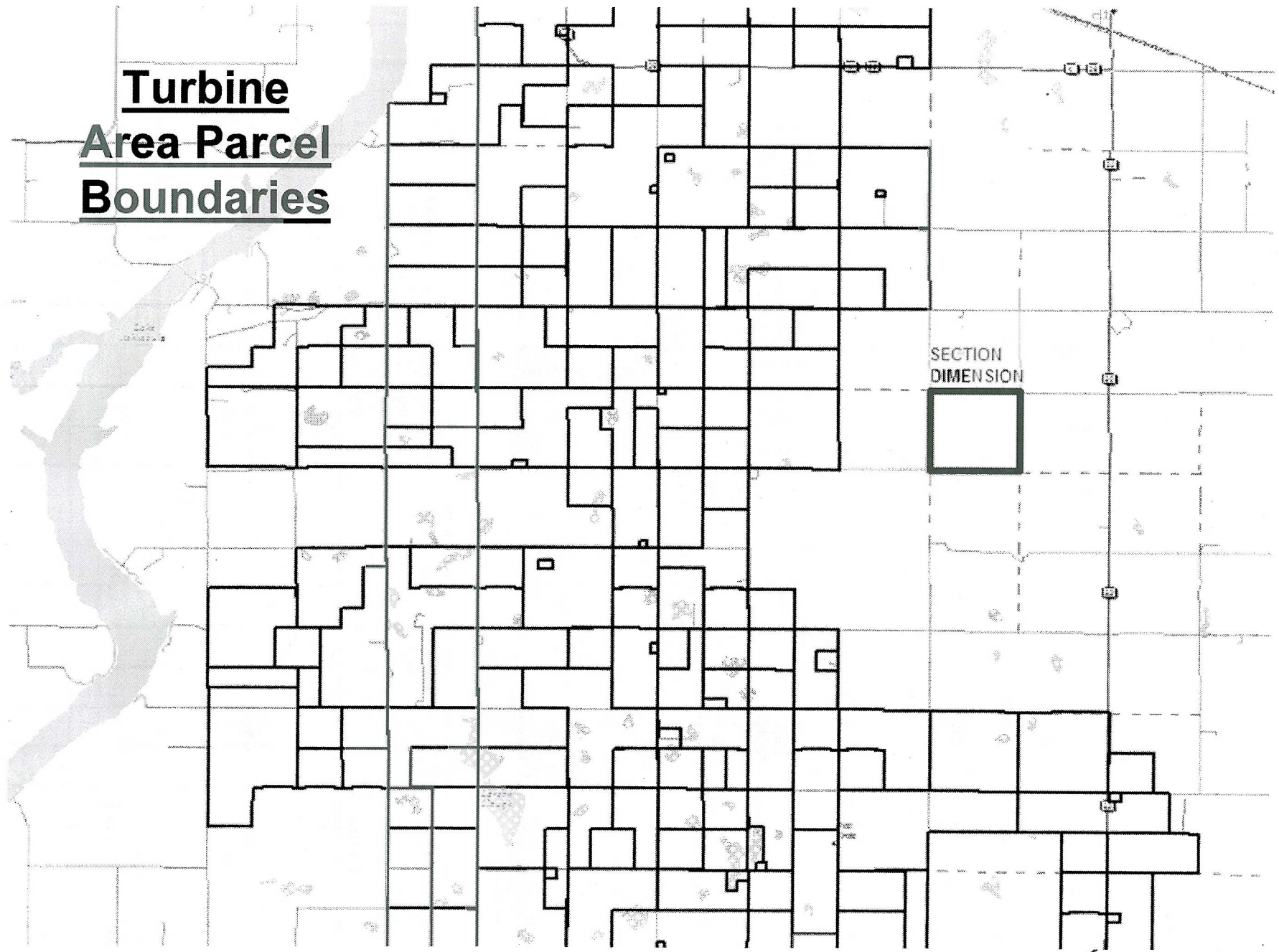
**5 rotor  
diameter  
adjoining  
property  
setbacks**

**(2.3 or 2.5 MW  
Turbines)**



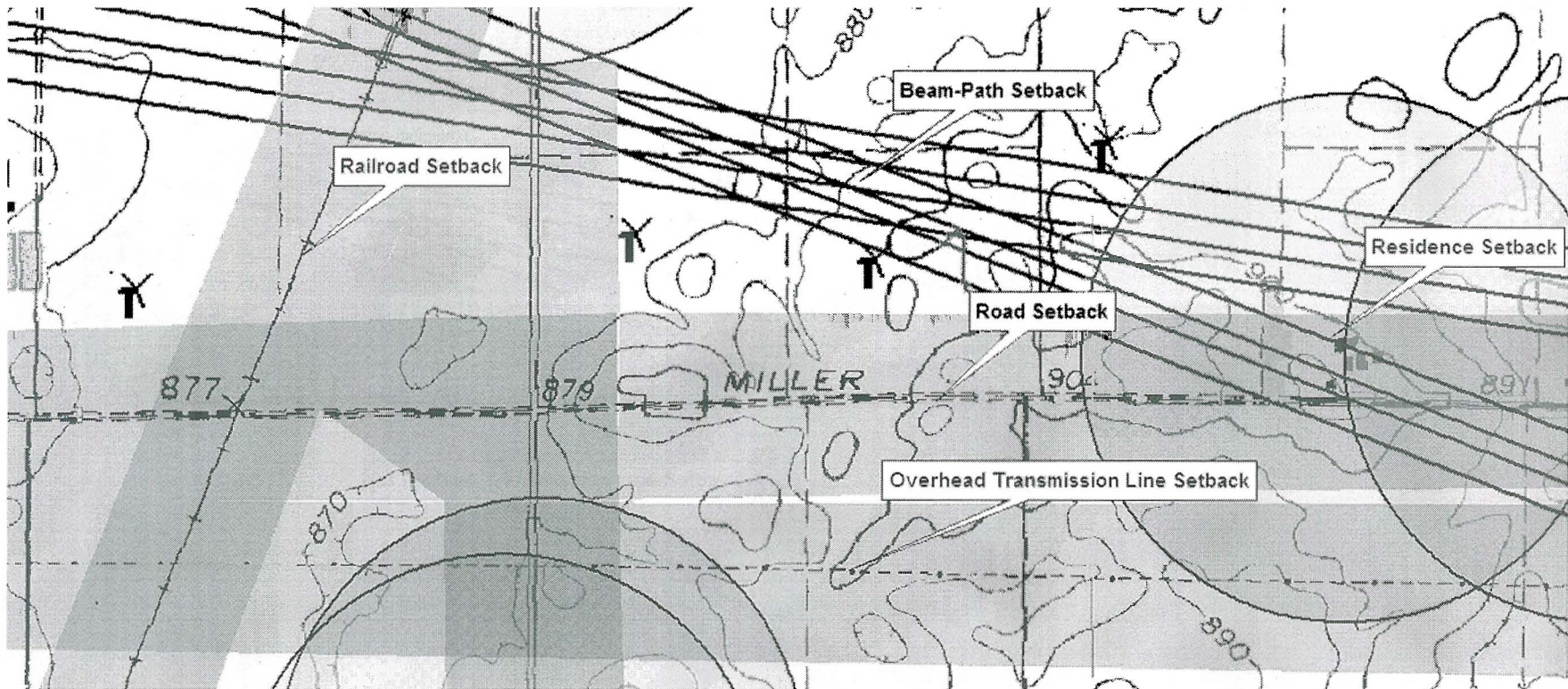


**Turbine**  
**Area Parcel**  
**Boundaries**





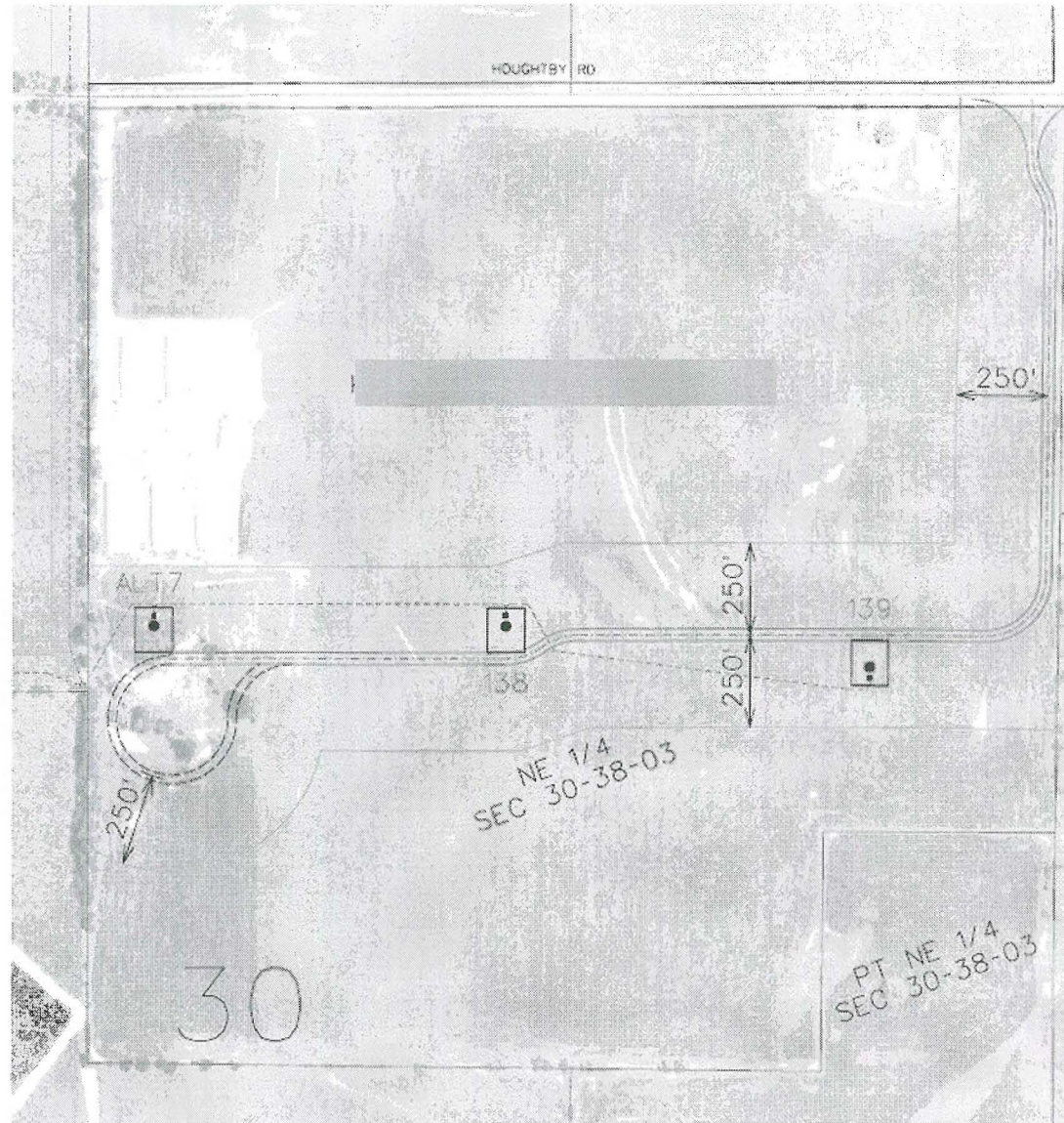
## Combined Impact on Design



Example of rail, road, transmission line, home, and beam-path setbacks that also meet land use requirements.

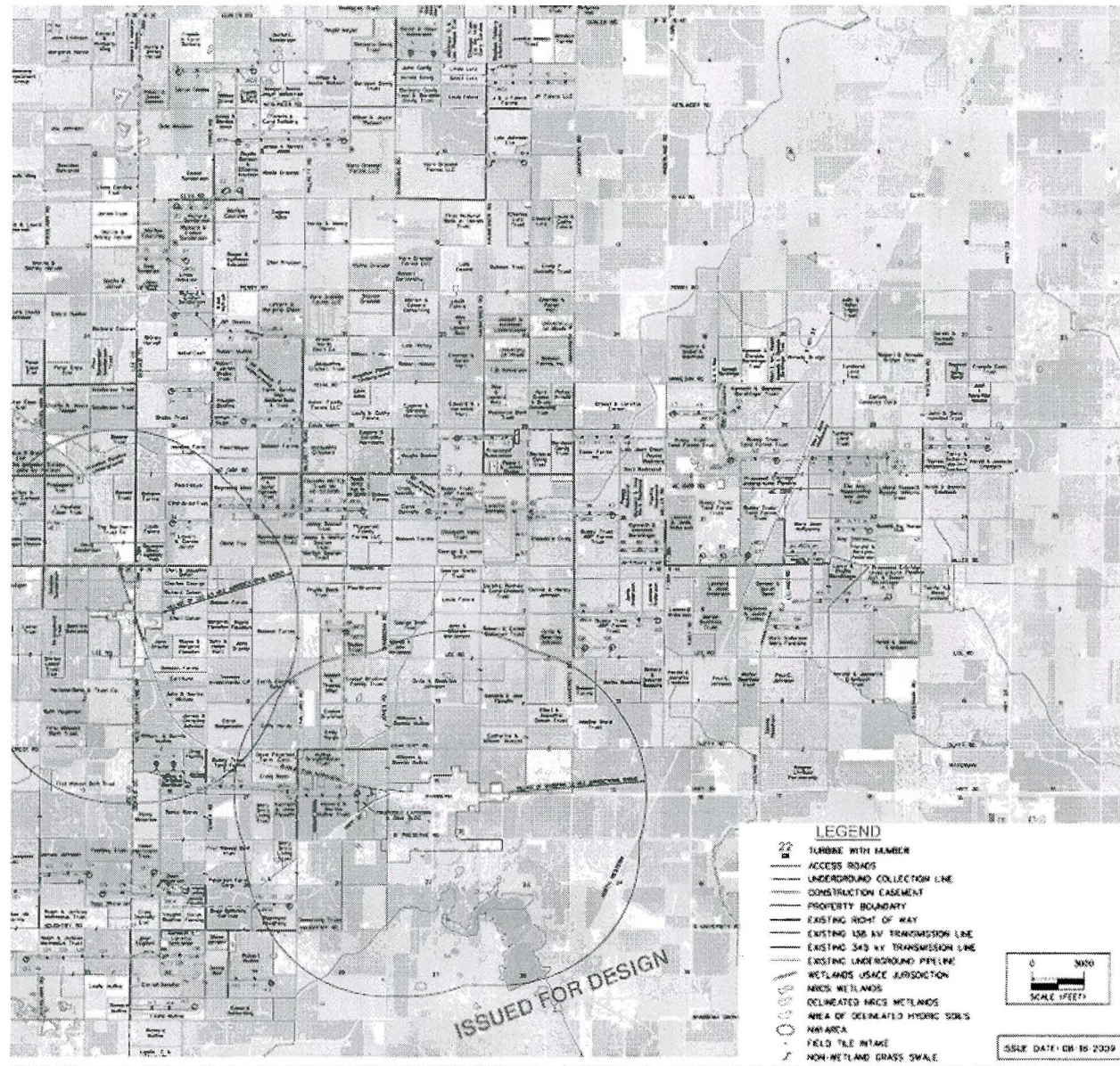


# Landowner Acceptance





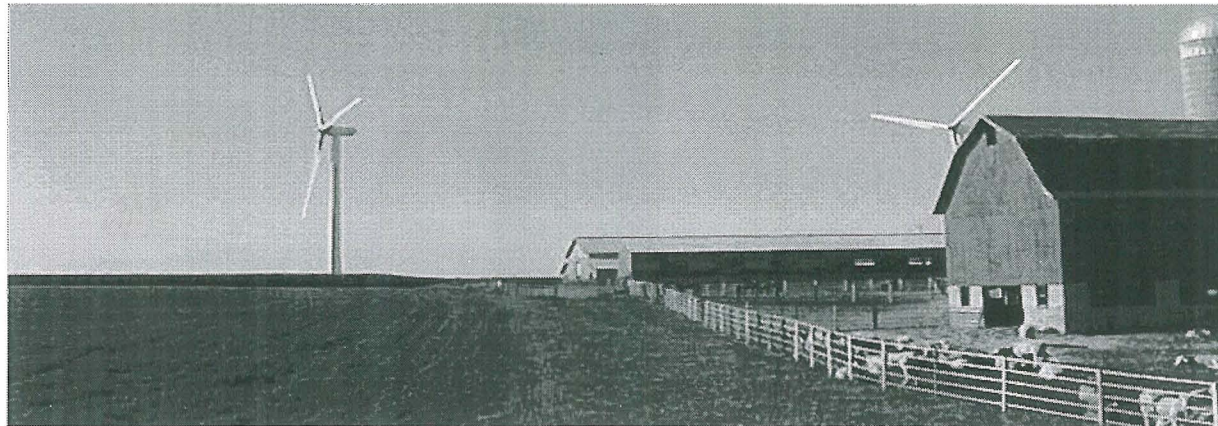
# Site Plan





## **Design Responds to Environmental Studies**

- Endangered/threatened species consultation
- Avian risk assessment
- Cultural resources review and avoidance
- General Permit for Storm Water Discharges from construction activities will be obtained prior to construction
- Wetlands delineation and avoidance
- Coordination with state and federal agencies



# **Turbine Sound Level Regulatory Criteria**

**Based on Extensive Industry Experience, are Designed  
to Protect Health and Well-Being**

USEPA  $L_{dn}$  Guideline – Levels of Noise  
Requisite to Protect Human Health and  
Welfare with an adequate margin of safety:

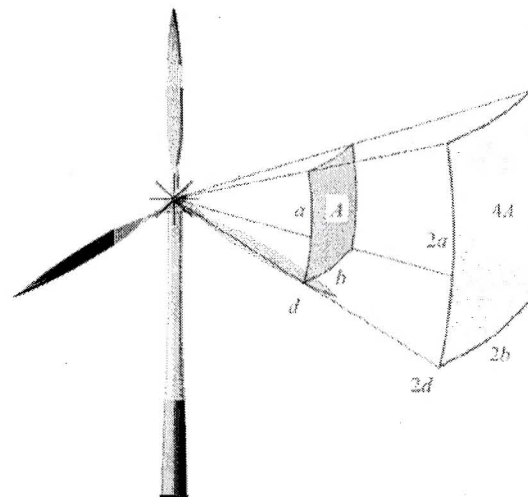
$$L_{dn} = 55 \text{ dB(A)}$$

For continuous sound level

$$L_{eq} = 48.6 \text{ dB(A)}$$

# Acoustic Propagation Modeling: Site Specific Application of Standards

- Atmospheric absorption
- Diffraction by topography and obstacles
- Complex terrain and ground attenuation
- Sound source direction
- Height of sources and receptors
- Seasonal foliage effects
- Frequency dependant sound propagation
- Meteorological conditions
- Specific wind turbine acoustics.

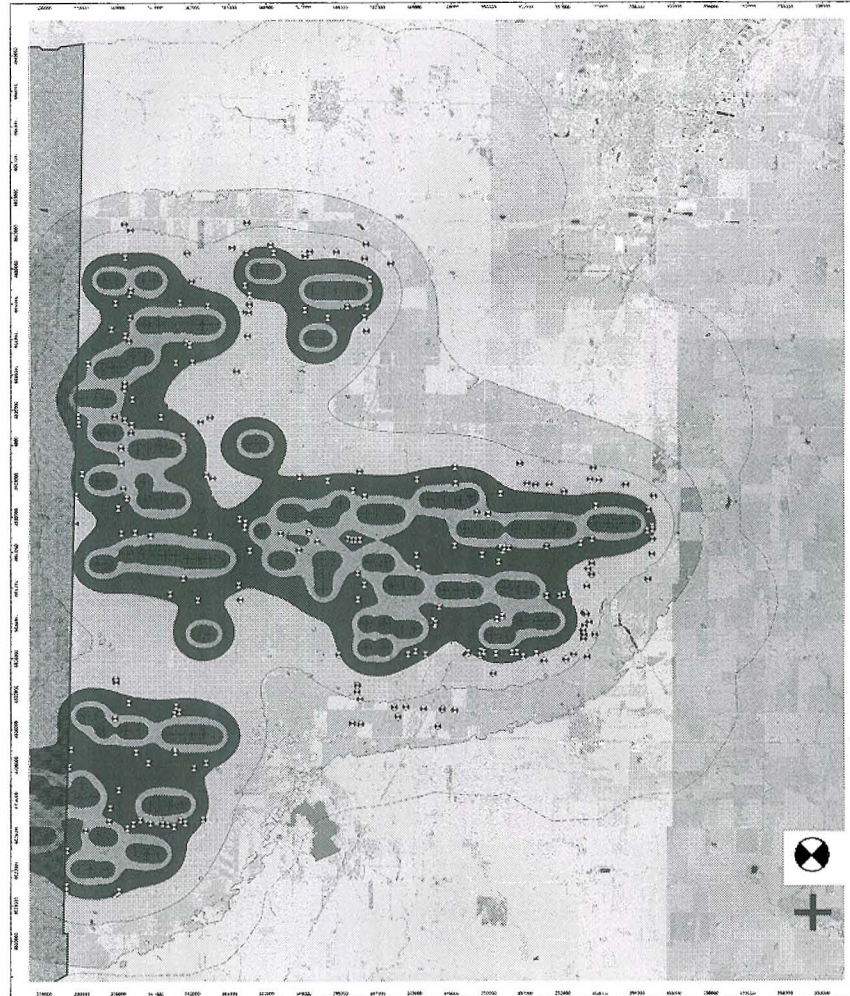




## Sound Studies:

### Reporting and Determination of Regulatory Compliance at Every Home for Every Turbine

- In Low Winds
- In Average Winds
- In High Winds
- At Specific Frequencies
- With all frequencies averaged
- During Day
- During Night
- For each season



## **Response to G.P. van den Berg Study**

### **Effects of wind profile at night on wind turbine sound**

- **Study doesn't predict site specific local terrain and atmospheric variations of different sites and different turbine models (previous slide)**
- **Study does not account for varying background sound levels at residences.**
- **Study states that wind shear does not result in higher wind turbine sound levels at distances of 400-meters**
- **EPA limits have been shown to be protective of health and welfare.**
- **EPA limits can be applied to turbine heights as well as 10-meter heights and differences in day time and night time background noise levels.**



## **Low-Frequency and Infra-Sound**

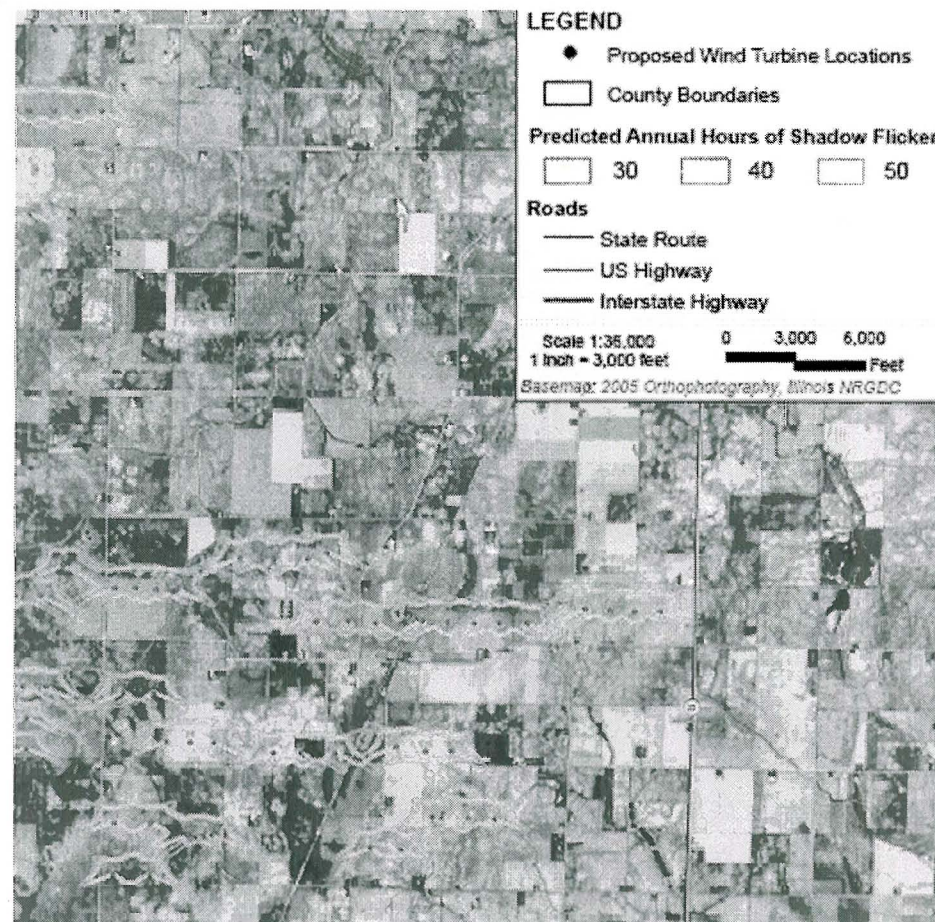
- **Low-frequency and infra-sound health effects and annoyance levels have been well studied in U.S. and Europe by published research**
- **Based on these studies, low-frequency and infra-sound criteria have been set in U.S. by ANSI**
- **Every wind turbine model has unique acoustic characteristics**
- **Epsilon measured low-frequency sound on GExle turbine**
- **There is no audible infra-sound to the most sensitive listeners**
- **At 1,000-feet low frequency and infra-sound is well below criteria set by ANSI**
- **NextEra wind farm will comply with ANSI standards for low-frequency and infra-sound at all homes in the area**

# Shadow Studies

## Conditions that create shadow-flicker

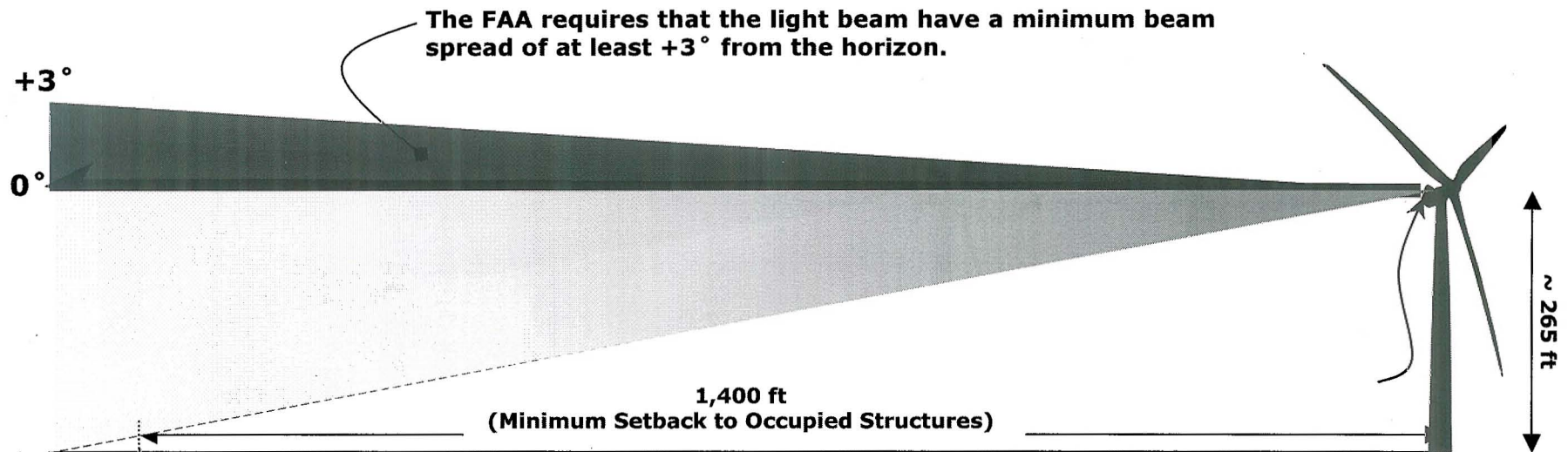
- Sunny
- Dawn or Dusk
- Wind from East or West
- Turbine must be within 30 degrees due east or west of home and about .5 miles of home
- Must have a window facing turbine

***NextEra designs to the standard that no home to have more than 1% of daylight per year exposure to shadow flicker and will address any complaint.***





# FAA Lighting



- LED lights pointing upward and encased in nacelle minimize light spreading below turbine
- No lights during day
- Synchronized flashing red lights on 30-40% of the turbines at night
- LED-based obstruction lights that have been shown to limit stray light to less brightness than a 7.5 watt light bulb
- No security lighting required at the base of the tower.

## Design Responds to Turbine Icing

- **Average is 1-2 icing events per year at this site**
- **The wind turbine has sensors that indicate when icing occurs.**
- **NextEra has an operational guideline to shut down turbines with the potential to shed ice that are within 800-feet of roads.**
- **With its 8,200 turbines and 10-year operational history, NextEra has never had an ice related injury.**
- **Statistical risk even without shutting down the turbine is near zero**

Wind Turbine Icing and Public Safety – Colin Morgan, Ervin Bossanyi, Garrad Hassan

Exploratory of HAWT Blade Throw Risk to Nearby People and Property – A.J. Eggers, Jr., W.E. Holley, R. Digumarthi, K Chaney

Risk Analysis of Ice Throw from Wind Turbines – H. Seifert, A. Westerhellweg, J. Kroning, April 2005



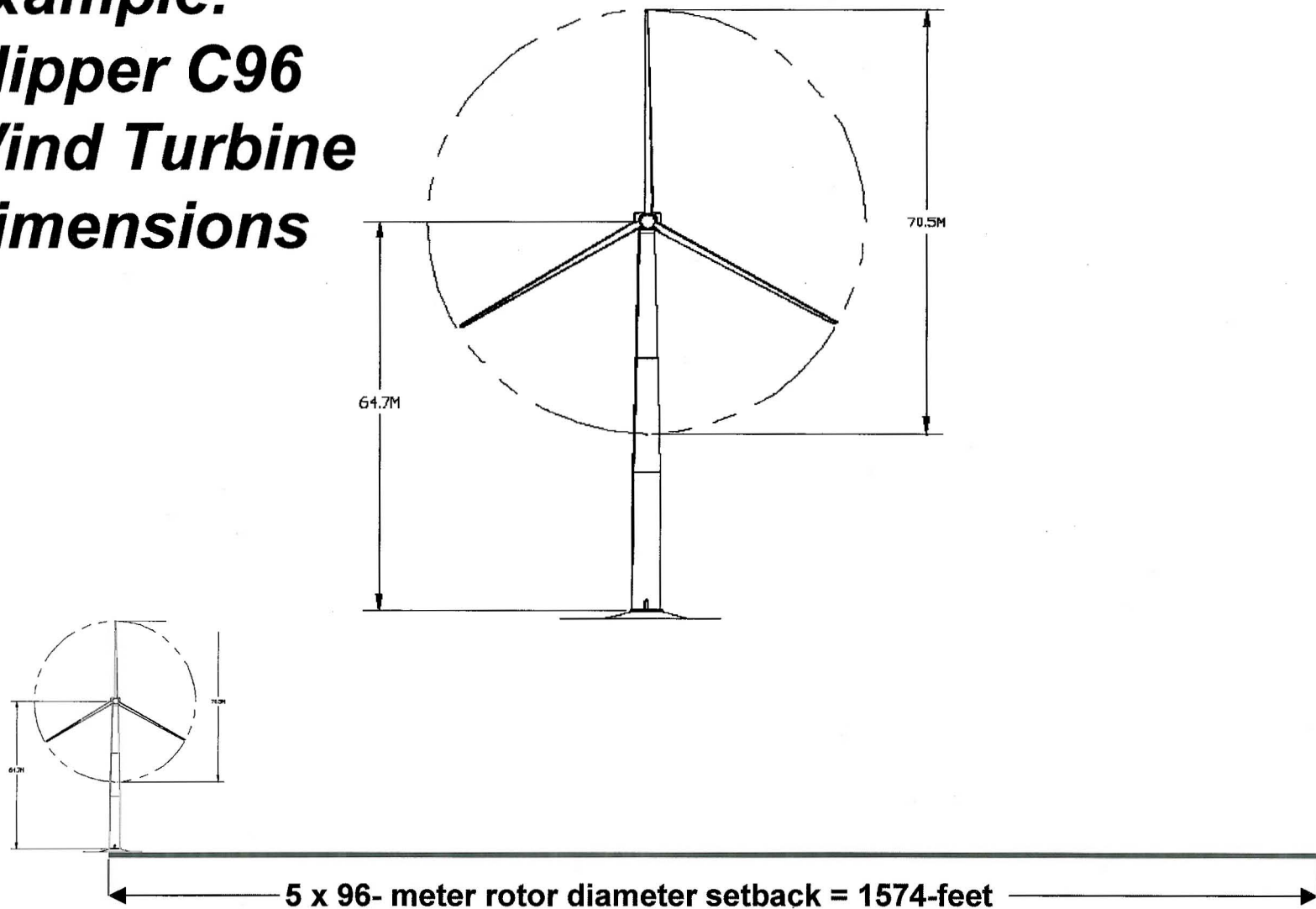


## **Electrical Considerations**

- **There should be no AM/FM radio, wireless internet, or TV interference**
  - If interference should occur, we will fix any problems
- **There is no stray voltage or additional lightning risk associated with installation and operation of a wind farm due to compliance with electrical grounding codes**
- **Electro-magnetic fields (EMF) are at about background levels 25 feet from turbine.**



***Example:  
Clipper C96  
Wind Turbine  
Dimensions***

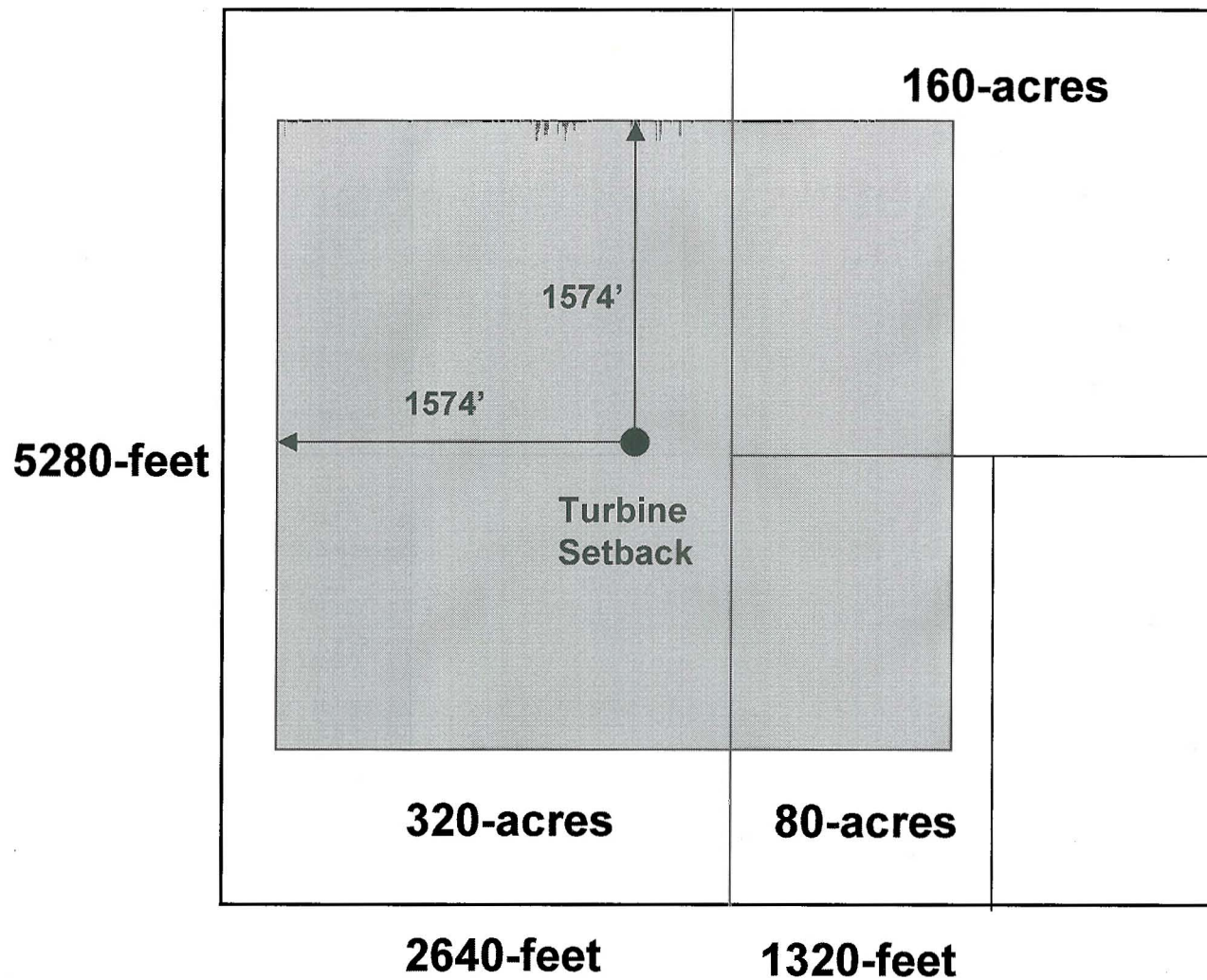




# Adjoining Landowner Wind Rights

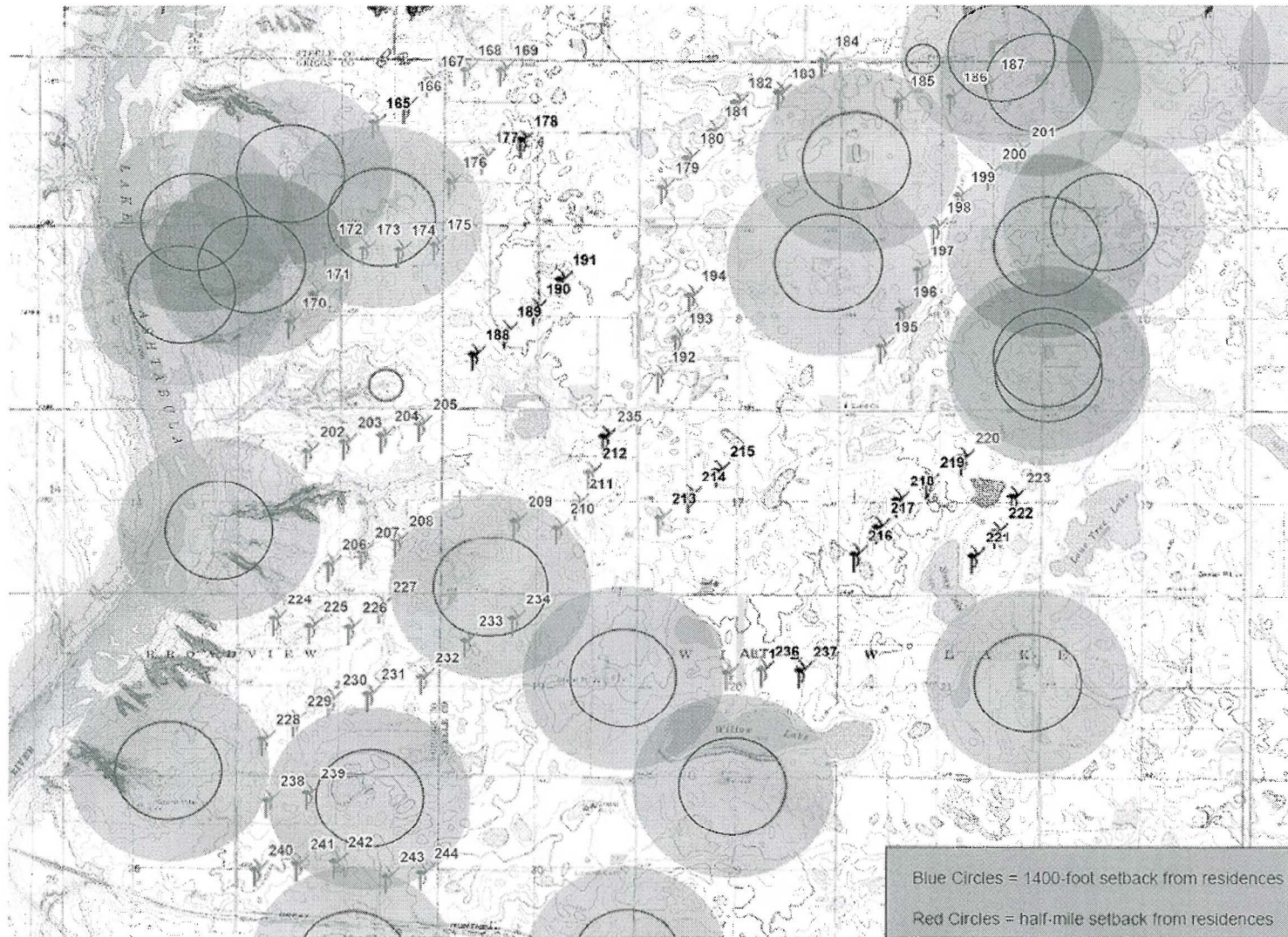
- There are no laws governing wind rights that address those rights extending beyond an Owner's property line
- All owners have rights to the wind that flows over their land
  - Mandatory setbacks are an abrogation of property rights (FROM PROPERTY LINES IN EXCESS OF SAFETY SETBACKS FOR WIND NON-OBSTRUCTION) CLARIFICATION
- In North Dakota with both North and South prevailing winds, Owners to the east and west of each other will have little impact on each other's wind
- Owners north and south of each other will have equal impacts on each other's wind
- No owner has a clear wind advantage
- Granting the construction of wind turbines does not limit the rights of adjoining landowners to apply to construct wind turbines in the future
- Not all land is equally suitable for wind turbines
- With 3 x 5 rotor setbacks, landowners with farmettes or smaller parcels who are opposed to wind projects can stop their neighbors with larger farms from having turbines.

## Section and Setback Dimensions (5 RD)





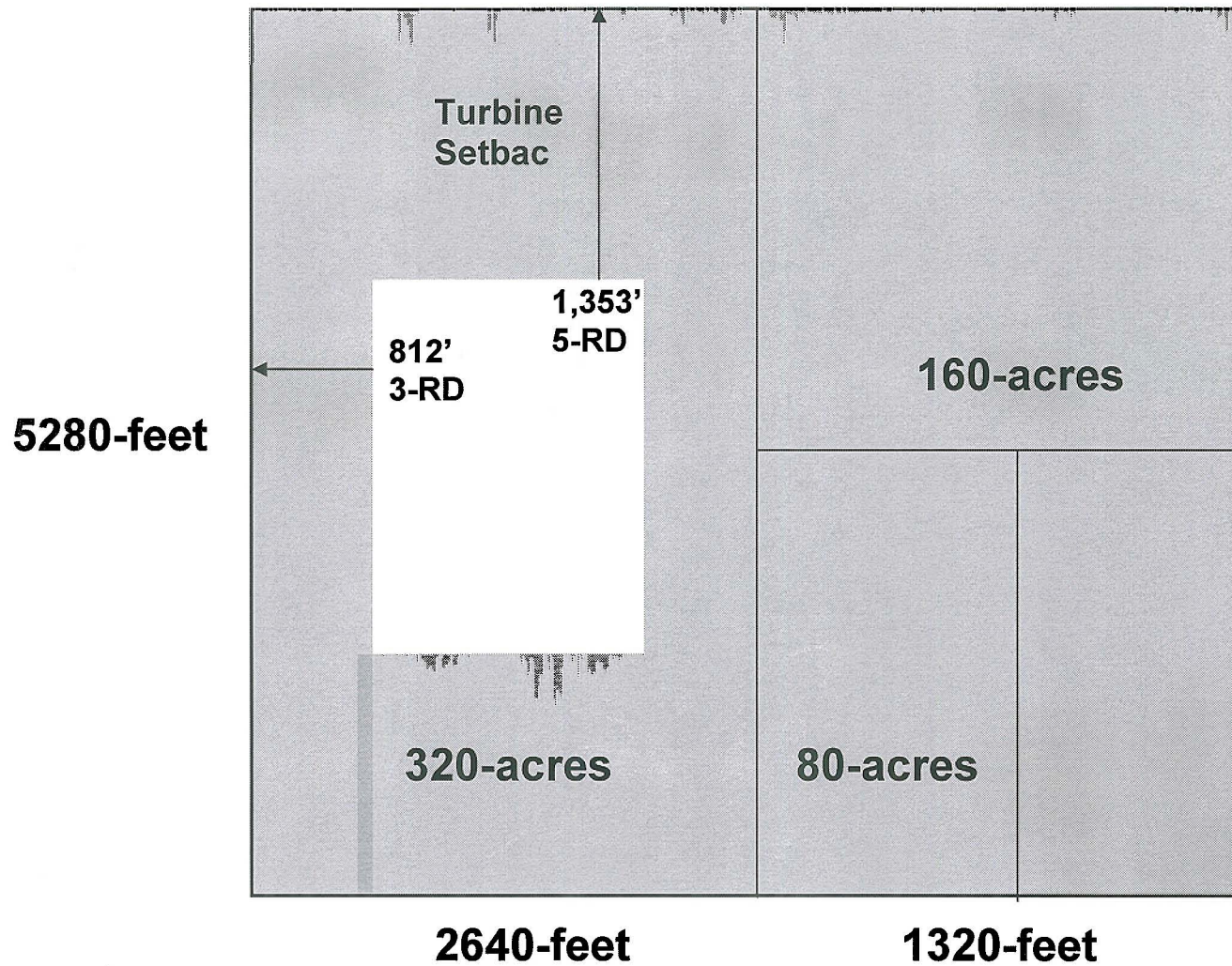
# Ashtabula Half-Mile Setback Impact





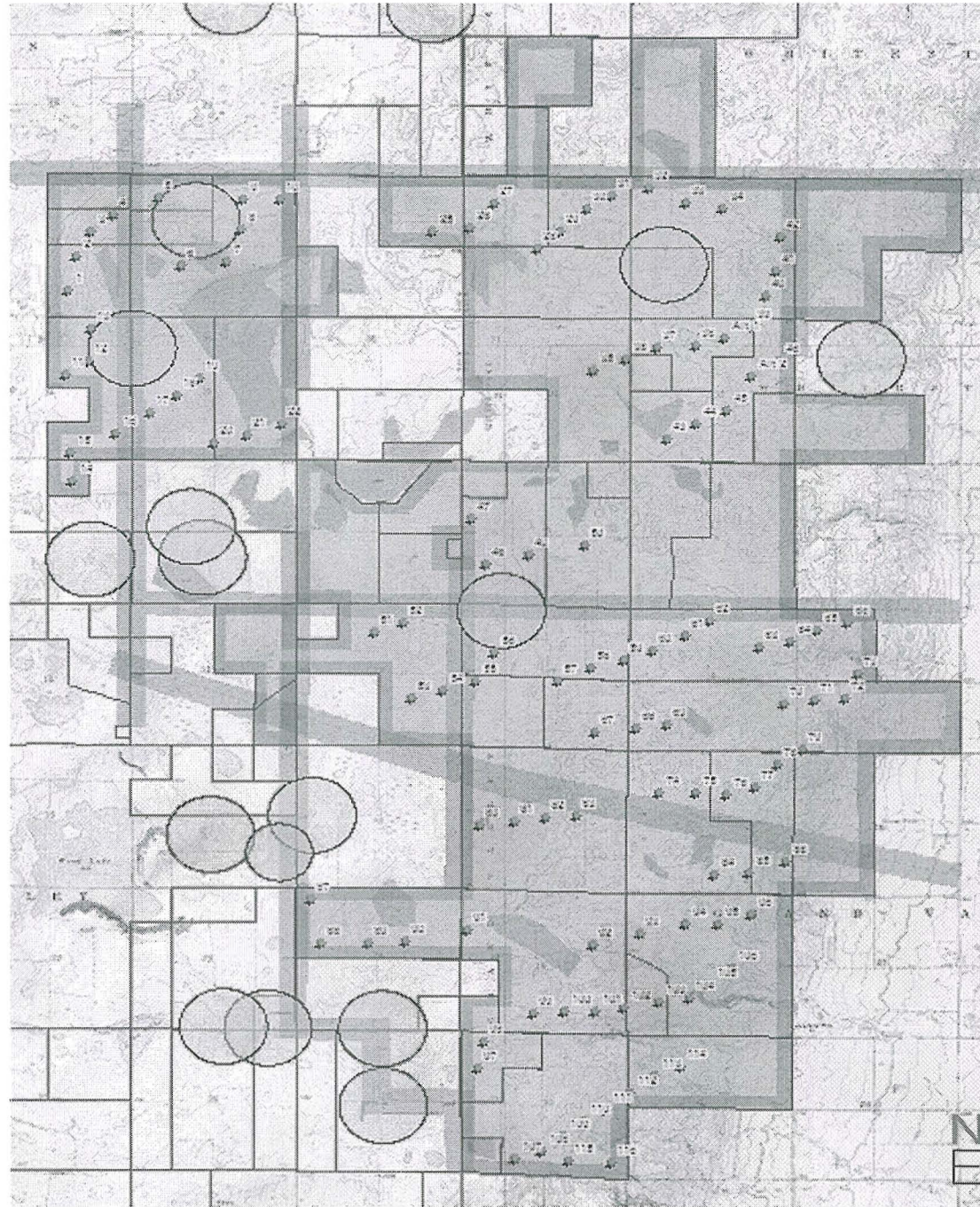
# GExle 5 Rotor-Diameter (1,353') Setback Impacts

Turbine possible only with ½ section or neighbor acceptance



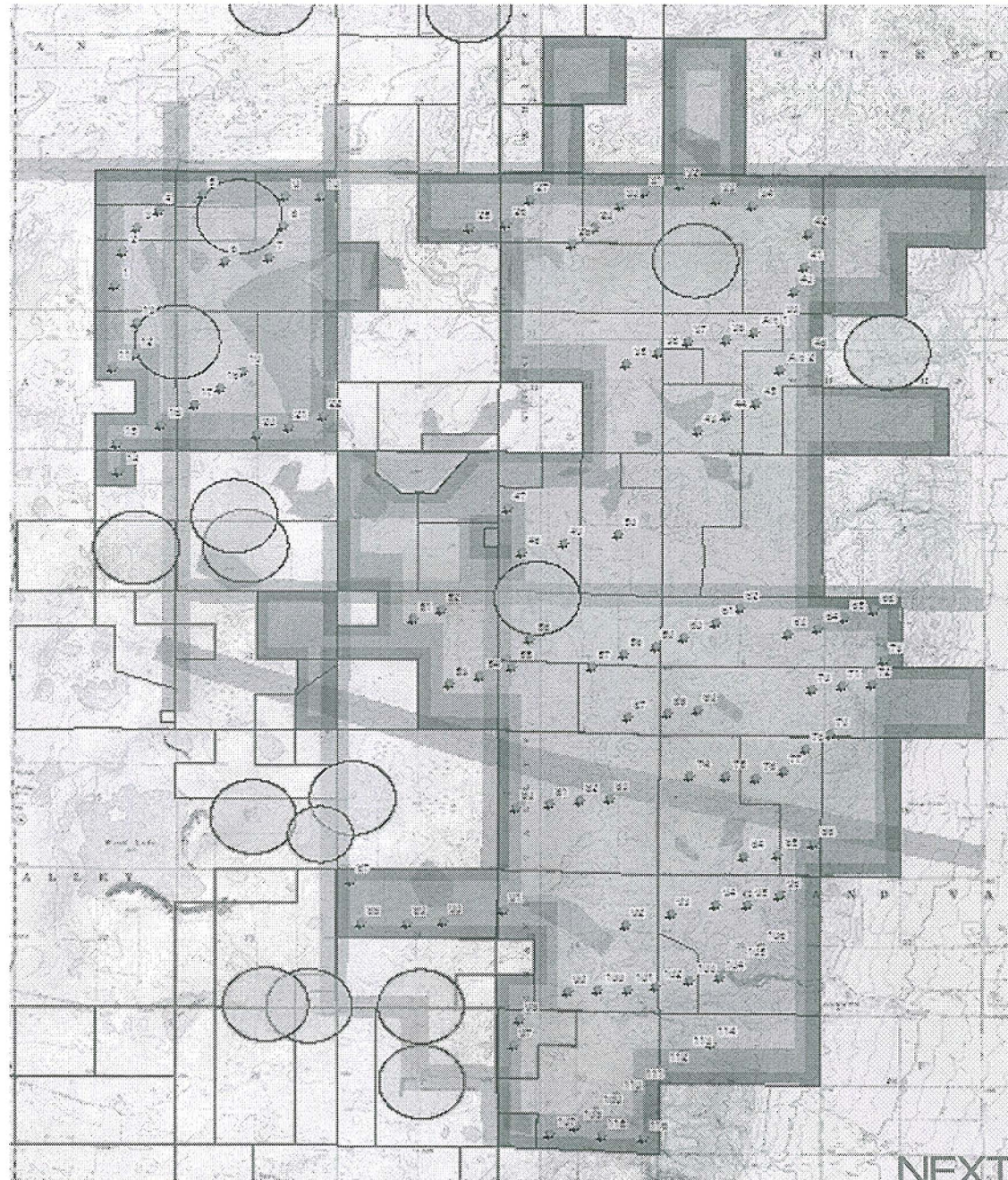


# Grand Valley with NextEra Setbacks





**Grand Valley  
with 3 x 5  
rotor  
setbacks**





## **Problems with Specifying** **Wind Non-Obstruction Setbacks**

- **Wind shadows can extend up to 30 rotor diameters from turbine (approximately 2 miles)**
- **Wind shadows vary with wind speed (longer in low winds, shorter in high winds)**
- **Wind shadows vary with terrain**
- **Wind shadow effect on energy production is based on a specific local “wind rose” (number of hours and amount of energy that comes from each wind direction)**
- **Wind shadows in North Dakota are reciprocal**
  - A turbine placed south of another will be shadowed in north winds but produce shadows in south winds
  - Turbines placed east or west of another will have little effect
- **Much land is unsuitable for turbines regardless of shadows due to low relative elevation, other obstructions, proximity to homes, wetlands, etc.**
- **Specifying a number of rotor diameters for standard setbacks does not account these considerations or changes in wind turbine size, technology, etc.**

**Siting Guidelines:**  
**NextEra Best Practices Summary**

**Sound Levels according to current USEPA guidelines  
For day and night levels**

$$L_{dn} = 55 \text{ dB(A)}$$

**For continuous sound level**

$$L_{eq} = 48.6 \text{ dB(A)}$$

**Minimum setbacks from roads, rails, and power lines of  
1.1 times the total height of the turbine**

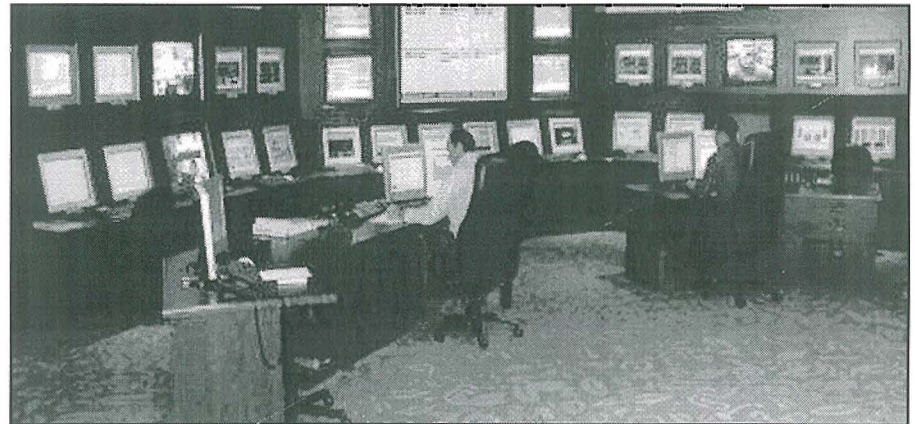
**Minimum setbacks from homes of 1400-feet along with  
conformance to USEPA sound levels**

**Shadow-flicker modeled not to exceed 30-hours per**



## Conclusion

- **Siting of wind farms is complex and precise**
- **Mandated setbacks in excess of 400-meters from homes and 1.1 times height from roads and property boundaries will abrogate landowner rights and make wind farms commercially unviable.**
- **EPA guidelines properly enforced protect health and welfare for sound issues**
- **Environmental, electrical, construction and operational safety is well addressed by existing agencies.**
- **Complaints can be resolved on a case-by-case basis**





### **Four Key Points:**

- NextEra Energy Resources has never received a confirmed or documented claim of health effects from anyone, despite deploying more than 8,000 wind turbines nationwide.
- Studies from other countries or other wind farms cannot be fairly applied to our wind turbines when analyzing health concerns or establishing set backs. These studies largely focus on larger or different model types, or older designs of wind turbines, instead of the newer design type turbines, or the specific models and sizes used by Next Era. Only a fair comparison of the same turbine types and identical set backs or arrays are appropriate. The level of sound and types of sound reaching neighbors must be determined on a case by case basis, depending upon the type of turbine involved, its characteristics, and how far a turbine is separated from a neighboring residence.
- The turbines we use feature “quietness warranties”, assuring that sound levels will not exceed certain pre-determined levels, and our wind farms are designed accordingly to assure that sound levels reaching residences do not reach levels that might be cause for concern.
- In addition to concerns about sound levels reaching residences, opponents of wind farms (and the studies they cite) have voiced concerns about two specific types of sound as they may effect health: (1) Infrasound and (2) Low Frequency Sound. Independent researchers commissioned by Next Era, as well as other independent researchers have documented that the wind turbines utilized by Next Era do not generate any infrasound at all. In addition, Next Era has carefully measured low frequency sound levels emanating from its wind turbines, and have proven that the level of low frequency sound generated by the wind turbine types that Next Era uses is far lower than the levels cited by anti-wind opponents as causing concerns.

### **To Provide Further Detail:**

- NextEra Energy Resources is the largest generator of wind energy in North America, yet it has never received a confirmed or documented claim of health effects from anyone, despite deploying more than 8,000 wind turbines nationwide.
- It is critical that a close look be taken at the “literature” that anti-wind opposition groups often cite. Those studies are based upon flawed and inapplicable literature. Studies from other countries or other wind farms cannot be fairly applied to our wind turbines when analyzing health concerns or establishing set backs. These studies largely focus on larger or different model types, or older designs of wind turbines, instead of the newer design type





turbines, or the specific models and sizes used by Next Era. Only a fair comparison of the same turbine types and identical set backs or arrays are appropriate.

- The levels of sound and types of sound reaching neighbors must be determined on a case by case basis, depending upon the type of turbine involved, its characteristics, and how far a turbine is separated from a neighboring residence.
- The turbines we use feature “quietness warranties”, assuring that sound levels will not exceed certain pre-determined levels.
- Despite the flawed nature of the literature relied upon by anti-wind opposition groups, NextEra Energy has reviewed and studied all such available literature to assure that our wind farms are not causing risk to humans, wild life or domestic animals.
- The literature cited by opposition groups focuses upon three different aspects of sound: (1) the levels of sound reaching residences; (2) Infrasound and (3) Low Frequency Sound.
- Our wind farms are carefully designed to assure that sound levels reaching residences do not reach levels that might be cause for concern.
- Despite the flawed nature of the literature relied upon by the opposition, NextEra Energy accepted at face value the claims made in that literature as to what levels of infra sound or low frequency sound would allegedly be responsible for health effects, and then conducted studies to determine if sound from the turbines used in Next Era’s wind farms would reach such levels.
- Independent researchers commissioned by Next Era, as well as other independent researchers have documented that the wind turbines utilized by Next Era do not generate any infrasound at all. These studies demonstrate, without contradiction, that the turbines used in NextEra wind farms will not generate any such sound that could cause harmful health effects.
- Historically, the only turbines that have exhibited this type of sound (infrasound) at any level of concern were the older type turbines with have their blades located leeward of the nacelle. NextEra Energy does not and will not install this type of turbine in the wind farms that it constructs.
- In addition, Next Era has also carefully measured low frequency sound levels emanating from its wind turbines (again accepting at face value the claims made in the flawed literature cited by opposition wind groups), and have proven that the level of low frequency sound generated by the wind turbine types that Next Era uses is far lower than the levels cited in the literature as causing concerns.
- ANSI standards and the United Kingdom’s DEFRA standards have been met.

- Studies and papers suggesting a link between sound from wind turbines and health (a) are based upon flawed reasoning and inapplicable comparisons, and (b) are not based upon any “peer reviewed literature” that are generally required prior to acceptance by the medical and scientific communities.
- Perhaps the most prominent of the anti-wind advocates is Dr. Nina Pierpont. While anti-wind advocates position her as a reliable and independent voice, she is in fact most biased and hardly independent. She first became involved in the anti-wind movement when a wind farm was planned near her home in up state New York, and she lined up to stop the development.
- Dr. Nina Pierpont, bases her conclusions (in the book she is trying to sell) upon incorrect, one-sided and misguided literature from the field of acoustic science, including one important paper written by Rick James. James’ deeply flawed paper is “The How To Guide to Criteria for Siting Wind Turbines to Prevent Health Risks from Sound”.
- The seminal premise of Mr. James’ “The How To Guide” relies upon a standard (ISO 1996-1971) that was withdrawn and superseded fully a quarter-century ago. When questioned about this under oath on May 11, 2009, Mr. James admitted this to be the case, but stated that he allowed the invalid standard to remain as the central premise of his “The How To Guide” because it was “easy to understand”. Careful examination of the use he made of this invalid standard (page 3 and 4 of “The How To Guide”) reveals this explanation to ring hollow. James merely used the (invalid) standard to castigate wind developers.
- Mr. James also completely misrepresents a very important study of wind turbines in the United Kingdom featured in “The How To Guide”. Referenced in his paper to stand for the proposition that wind farms are dangerous because of low frequency noise and must be protected against by substantial setbacks, Mr. James completely ignores the key findings of the United Kingdom study that he references (“The Hayes McKenzie study”), which are completely contrary to his conclusions.
  - The three wind farms that Hayes McKenzie studied found that the wind farms were not emitting low frequency sound;
  - That only 3 of 126 wind farms in the United Kingdom emitted low frequency sound;
  - That infrasound associated with *modern* turbines is not a source that will result sound levels that will be injurious to the health of a wind farm neighbor;
  - That low frequency sound was measurable on a few occasions, but below the level of concern.



- Implicit therefore, in the very study cited as authoritative by James, is the fact that a determination of whether a wind turbine can cause harm to health must be individually studied and determined on a case by case basis, depending upon the type of turbine involved, its characteristics, and how far it is separated from a neighboring residence.
- In addition, Dr. Pierpont's opinions are based upon, and she cites with approval the work of James and his "The How To Guide". Because Dr. Pierpont uses James work as the foundation for her opinions, her work is in turn deeply flawed.
- In addition, Pierpont references the study known as the "Recommendations of the French National Academy of Medicine", and relies upon this study in making her conclusions about wind farms. However, those studies (and the more extensive set backs they recommend) are based upon a 2.5 megawatt wind turbine, rather than upon the much smaller turbines utilized by Next Era Energy in its wind farms. It only makes sense that a larger machine would be slightly louder than a smaller one, that a set back for a much larger machine would therefore be greater, and it is unfair (and unscientific) to suggest that the set back for both machines should be the same. "The French Study" is therefore completely inapplicable, and inappropriate to use in comparisons. its' use by the objectors is unfair and misleading.
- While Dr. Pierpont has coined the phrase 'Wind Turbine Syndrome', it is important to note that 'Wind Turbine Syndrome' is not an accepted or recognized disease or malady in either general scientific or medical communities. For example, Wind Turbine Syndrome is not recognized by:
  - The American Medical Association
  - The National Institute of Health
  - The Environmental Protection Agency
  - The World Health Organization
  - The Centers for Disease Control
  - The Canadian Medical Association
  - Any Leading Medical Journals of Institutions
- It is important to point out that Pierpont's work has not been published in peer-reviewed journals, a fact that raises additional questions as to the scientific validity of her research. In short, her views, however, are not supported by scientists who specialize in acoustics, low frequency sound and related human health impacts.
- Moreover, surveys of peer-reviewed scientific literature have consistently found no evidence linking wind turbines to human health concerns. It is important to note that all wind energy projects are required to undertake environmental assessments that determine the potential impacts of wind turbines on ecosystems and human health. The studies also ensure that the installations meet strict government regulations with respect to sound.

From:  
NEXTERA ENERGY

## Response to G.P van den Berg Study:

### EXECUTIVE SUMMARY

Erik J. Kalapinski, INCE | Sr. Sound and Vibration Engineer  
Tetra Tech EC | Energy Program  
133 Federal Street, 6th Floor | Boston, MA 02110 |

1.) Wind shear effect is of principal importance for regulatory compliance demonstrations in states/localities that have noise limits that are relative to existing conditions. Comparatively, in the absence of a state or local regulation, the EPA limits provide absolute sound levels. EPA limits have been shown to be adequately protective of both health and human welfare.

2.) Wind shear does not result in wind turbine sound levels being higher than maximum levels specified by wind turbine manufacturers. It simply means that the wind turbine may get louder 'faster' than expected during high wind shear events. This is due to higher wind speeds at hub height as compared to ground level, i.e. reduced masking. The IEC 614100-11 test standard, which assumes a stable atmosphere with a logarithmic wind profile and is used by manufacturers to report sound power levels, is currently under revision to report sound levels at reference hub height.

3.) The Van de Berg paper clearly states that wind turbine sound levels at distances of 400m (the minimum setback distances employed by Nextera is 426m) 'perfectly match' emission levels. This is also consistent with what we see in practice and validates the use of the ISO 9613-2 modeling approach. Wind shear has limited effect on propagation/attenuation at these shorter propagation distances, having a more pronounced effect at receivers located at distances further from the wind turbines.

4.) The Van de Berg paper also states that ISO 9613-2 may underpredict sound levels by 3 dB at distances of 1-2 km. Tetra Tech incorporates a range dependant correction factor (Cmet) to account for anomalous conditions which may aid in long range propagation due to the atmosphere being capped and acoustic rays being bent back down to the ground due to variation in sound speed profiles over extended distances, i.e. as what may occur during low level jet or high wind/temperature gradients in the NIA/permitting documents. While received sound levels may be higher at these distances, they are still subject to geometric divergence and air attenuation and will always be lower than at receptors located at closer (i.e. 400m) distances and is not expected to result in nor contribute to an exceedance condition.

For resolving issues with a complaining landowner:

Compliance testing is performed inclusive of long term testing (~2 weeks) at the receptor of concern as well as short term testing in accordance with IEC 614000-11 standard to determine if the closest wind turbine(s) are operating within manufacturers guaranteed emission levels. All or just part of this work plan may be appropriate for depending on the situation. Long term testing (unattended monitor) is typically done to measure over a range of operational and atmospheric conditions.

If 'compliance' is demonstrated at both the receiver and source, candidate mitigation includes plantings in proximity to increase masking (though under high wind shear events would have limited effectiveness), increasing insulation or window replacement (the latter does not mitigate



when windows are open), or heavy window treatments in bedrooms, similar to what is done for shadow flicker mitigation. The most effective measure is the installation of a ceiling fan to increase 'background' and mask the very low level wind turbine sound levels, if perceptible indoors. If testing indicates elevated sound levels, other mitigation methods are not satisfactory, and the turbine is operating within manufacturer warranty levels, operational restrictions during nighttime periods with high wind shear by limiting tip speed when ground level wind speeds are comparatively low is another option and is available on the GE and several other manufacturers turbines.